

Section 7

Other States' Current Agricultural Water Use Measurement Legislation

Attached is a summary of other states' current legal and regulatory approach to agricultural water use measurement. This material was developed by the Technical Team to support the Panel's October 2001 interim deliberations.

PRELIMINARY SUMMARIES

MEASUREMENT IN SELECTED STATES

Background and Purpose

The purpose of this section is to describe existing legal rules and programs pertaining to measurement of water use in selected states other than California. The information is summarized below in two forms: (1) a table; and (2) a narrative summary. The purpose of the table is to summarize the information from the narrative and to provide a tool for creating comparisons across states.

This information was prepared at the recommendation of the Panel based upon its June 2001 meeting. The information collected is intended to facilitate Panel and technical team work in identifying various possible approaches for measurement of agricultural water use in California.¹

Collectively, the states consulted provide potentially helpful models and approaches for California to consider. Individually, however, it appears that no single state consulted provides a perfect ideal for California to follow. For example, California is not principally dependent upon groundwater, and not substantially free of extensive government-owned conveyance facilities. Thus, rather than attempting to pick one state and duplicate its approach to measurement, it is recommended that readers regard the whole of the summary as providing background and potential ideas for formulating measurement approaches in California.

Research Method

This information was developed through a review of statutes, regulations, agency guidance documents, internal agency memoranda, and other documents describing measurement programs in other states. In addition to a review of documents, agency staff in the six featured states were interviewed by telephone.

The interviews were open-ended and qualitative, and generally occurred following the interviewer's review of statutes and other main documents. Drawing on the review of state documents, the interviewer verbally confirmed major understandings and impressions regarding the workings and emphases of the subject state's programs. In particular, the interviews focused

¹ Because these summaries will be made available to the public through a variety of means in the future, it is necessary to state that the information presented here is a summary only and omits information not relevant to the purpose for which it was prepared. It was prepared only for the purpose of helping to facilitate the Independent Panel review process described in other sections of these materials, and it should not be relied upon by persons for any other purpose, such as by individual water users as a basis for decisionmaking, or for identifying their legal obligations.

on the following questions, which were previously submitted to the Panel following the Panel's June meeting:

- Who requires or provides incentives for water use measurement?
- Who measures water use? Where and how?
- Who compiles, stores, distributes and uses measurement information and how?
- What are the purposes, benefits, and problems of the approach taken in your state?
- Does actual practice live up to the intended policy incentives or legal requirements?

In addition, interviewees were asked the following questions:

- What are the most important states to look at as examples?
- Who should we talk to?
- What helpful documents already exist? For example, has your state prepared any cost-benefit analyses regarding implementation of a measurement program or individual measurement requirements?

The sample of six states is not meant to be an attempt at a statistically representative sample. The sample of states presented here was developed opportunistically, after narrowing the field with some broad criteria. It was thought that western states would provide the best starting point for research. Also, it was thought that the sample should include both coastal states and states with some focus on groundwater. Some Panel members also suggested that particular states should be toward the top of the list of those consulted.

Initial attempts were made to identify key agency personnel with oversight responsibility for measurement programs in a number of states. When the agency personnel were eventually interviewed and asked which other states should be consulted, in several instances they named one or more of the states already on the priority list. After six states had been surveyed in this way, it was felt that a variety of approaches to measurement had been represented, and that any further review of additional states should be done if it were thought that a particular missing state's program might add something helpful to the overall picture.

Persons interviewed for the summaries below were from state agencies that oversaw state water management, administration of the state's water rights system, or both. All appeared to be experts in regard to their own programs, and all had direct managerial responsibility for measurement-related programs within their agencies, or had more senior managerial oversight of broader areas of agency function.

Summary

Generally speaking, the picture of measurement presented below indicates that other states have been and are actively engaged with the issue of agricultural water use measurement in a serious fashion. The mechanisms that they use are somewhat different in each case. Drawing from the six collectively, one can summarize some of the elements of a measurement program as follows:

- Typically there is a required minimum degree of accuracy for measurement devices and methods.
- There may also be a required method for validating or certifying measurement devices and methods as meeting the accuracy requirement.
- A variety of variances and exemptions from various requirements are typically provided for.
- It is may be helpful to distinguish between various elements of the program. For example, after installation of methods and devices, states may vary in whether measurements are reported by water users or by agency staff (e.g., agency-employed watermasters). Depending upon desired program design, the following duties or rights may be allocated in a variety of ways amongst users, agency staff or others:
 - the duty to construct or install the measuring device or method;
 - the duty to calibrate and maintain the equipment;
 - the duty to read and record measurements;
 - the duty to confirm degree of accuracy of measurement methods and devices;
 - the duty to confirm degree of accuracy of the calibration of methods and devices;
 - the duty to maintain measurement records;
 - the duty to report measurements;
 - the duty to store and manage reported data;
 - the duty to compile data;
 - the duty to track and verify individual compliance with measurement and reporting obligations;
 - the duty to perform quality assurance on compiled data;
 - the duty to summarize and present compiled data in reports or plans; and
 - the right of access to data.
- There appears to be a direct relationship between the number of physical locations at which measurement is required and the needed agency staffing levels.

PRELIMINARY TABLE SUMMARY MEASUREMENT IN SELECTED STATES

Row Number		Kansas	Oregon	Washington
1	Purposes of Measurement Program	<p>The principal purpose of the measurement effort is “water management.” Measurement information is used to revise standards for what is a “reasonable” maximum use of water for particular types of beneficial uses. Those maximum amounts are used in all new permits. After perfection, the right is limited to actual demonstrated reasonable and beneficial use.</p> <p>Other stated purposes include effective administration of water rights to prevent impairment, to protect minimum desirable stream flows, to conserve water, or to otherwise carry out the duties of the chief engineer as set forth in statutes.</p>	<p>Increasing user awareness of the amount of water they use to improve self-regulation and business operations and plans.</p> <p>Providing reliable evidence for water right holders to rebut allegations of forfeiture for non-use.</p> <p>Assisting watermasters in the effective distribution of water in accordance with the rights of record.</p> <p>Providing accurate information to help with in-stream flow monitoring, streamflow restoration projects, or improved water distribution efforts for fish and habitat.</p> <p>Refining and updating the water availability model, which is used to evaluate whether new water right permits may be issued.</p> <p>Providing information demonstrating actual use as evidence for water right certification.</p> <p>Supporting injury/no-injury determinations for proposed water right transfers, permit amendments, exchanges and voluntary in-stream leases.</p> <p>Supporting decision-making for projects to conserve water under the Allocation of Conserved Water program under which users may keep some of the water that they conserve.</p> <p>Supporting agency actions regulate use for the protection of senior water rights.</p>	<p>Maintenance of adequate in-stream flows for protection of salmonid habitat.</p> <p>Verifying water rights compliance.</p> <p>Providing a basis for curtailing diversions in excess of authorized water rights in order to make more water available for aquatic habitat.</p> <p>Determining the availability of water for further appropriation.</p> <p>Identifying opportunities for more efficient water use;</p> <p>Conducting any needed hydrologic studies.</p>

Row Number		Kansas	Oregon	Washington
			<p>=====</p> <p>Acting as an early warning system for catastrophic flood events.</p> <p>=====</p> <p>Helping to coordinate water release schedules for stored water.</p> <p>=====</p> <p>Helping to monitor the status of critical ground water areas.</p>	
2	Who requires or provides incentives for measurement?			
2a	Judges, by decree (adjudications)	Yes	Yes	Yes
2b	Legislature, by statute requiring measurement.		By all governmental entities who hold a water right.	By any owner of any water diversion. <p>=====</p> <p>Agency enforcement is required in fewer circumstances than those in which measurement is required.</p>
2c	Statute gives agency discretion to require measurement of water use.	By any water user.	<p>By any holder of a water right permit (permits "shall set forth any terms, limitations and conditions as the department considers appropriate")</p> <p>=====</p> <p>By the owner of any ditch or canal.</p> <p>=====</p> <p>By "affected water right holders" where the Commission adopts a rule to designate an area as having "serious water management problems."</p> <p>=====</p> <p>By appropriators or users of any public waters of the state.</p> <p>=====</p> <p>(Statute also allows agency to provide a funding match of monies needed for installation and maintenance of measurement devices (currently unfunded).)</p>	By persons obtaining new ground water rights permits.
3	What is the mechanism for imposing measurement requirements on particular	By conditions in water rights permits.	By conditions in water rights permits triggered at issuance for large diversions or upon posting of a "headgate notice" for smaller diversions. <p>=====</p>	By statute. <p>=====</p> <p>By conditions in water rights permits.</p>

Row Number		Kansas	Oregon	Washington
	users or groups of users?		By administrative rule (applied to an area with “serious water management problems”; never used so far)	
4	How is the manner in which measurement must occur specified?	Very strong emphasis in the regulations on manufacturer demonstration of quality assurance, as well as proper installation and maintenance. Agency lists or guidelines that are referenced in regulations and identify acceptable methods or devices.	Regulations that specify methods and performance standards but not particular devices.	Regulations that specify methods and performance standards but not particular devices.
5	When required, where must measurement devices be located?	All nondomestic, nontemporary wells, pumpsites and gravity diversions.	At such points as may be necessary.	
6	Reporting and data management.	Initially, the Division of Water Resources (which handles water rights issues) enforces the measurement and annual reporting requirement and enters the data into the computer system. The Kansas Water Office (which is the state’s water planning agency) then compares the data to existing standards and makes sure the data is consistent with known typical water uses for various beneficial uses. The agencies follow up together in contacting users of atypical amounts to clarify the numbers. The “cleaned up” data is then included in the final database used for planning and other purposes.		Require reporting of maximum instantaneous flow rate and annual total volume. ===== Required frequency of recording increases with size of diversion.
7	Issues (Problems, Constraints, Benefits)	Referred to strong emphasis in regulations on manufacturer certification, installation, and maintenance as removing poor products from market, and increasing quality of data and straightforwardness of agency task in using data.	Referred to staffing levels as limiting the agency’s ability to perform adequate data quality assurance.	Referred to staffing levels as limiting the number of points at which measurement can be enforced
8	Theory vs. Practice		Where measurement is required by permit condition, they have less than a 50% compliance rate.	A lawsuit successfully challenged the agency for failure to properly implement statute.

Row Number		Arizona	Colorado	Idaho
1	Purposes of Measurement Program	<p>Providing data for budgets of water use and trends, as well as flow models.</p> <p>====</p> <p>Providing information for compliance work, to ensure that persons take no more water than they are rightfully entitled to (including as an input to calculations of exceedances under the state “flexibility account” system).</p> <p>====</p> <p>Helping farmers to accurately know at what point to stop applying water based on crop-specific irrigation needs.</p> <p>====</p> <p>Computing the amount of tax owed by each groundwater user.</p>	<p>Monitoring water use to ensure that it is in accordance with water rights.</p> <p>====</p> <p>Limiting waste of water.</p> <p>====</p> <p>Improving water management.</p> <p>====</p> <p>Providing water right owners with an official record that can be certified to the courts, providing a basis for proving historic use in a change of water right case or sale of water right.</p> <p>====</p> <p>Helping Colorado to meet interstate compact requirements.</p>	<p>Helping in enforcement against excessive use.</p> <p>====</p> <p>Helping to ensure delivery of the correct amounts by the watermaster.</p> <p>====</p> <p>Protection of the users’ rights in adjudications and transfers by reliably documenting various uses.</p> <p>====</p> <p>Ensuring and demonstrating compliance with interstate compact requirements.</p> <p>====</p> <p>Contributing to planning and scientific work relating to statewide water resource management.</p>
2	Who requires or provides incentives for measurement?			
2a	Judges, by decree (adjudications)	Yes	Yes	Yes
2b	Legislature, by statute requiring measurement.		<p>By owner of any irrigation ditch, canal, flume, or reservoir in the state taking water from any stream, at point of intake</p> <p>====</p> <p>By owners of any irrigation ditch, canal, or reservoir, transferring water from one natural stream to another, or from a reservoir, ditch, or flume to a stream for diversion</p> <p>====</p> <p>By owners of any reservoir in the bed of any natural stream or through which any natural stream flows, in the bed and channel of every natural stream or watercourse discharging waters into said reservoir</p> <p>====</p> <p>Anyone transferring water from one public stream to another, at the point where the water leaves its natural watershed and is turned into another and also at the point where it is finally diverted for use from the public stream</p> <p>====</p> <p>Where the owner of a reservoir delivers stored water into a ditch</p>	

Row Number		Arizona	Colorado	Idaho
			<p>or into the public stream and takes in exchange water from the public stream higher up</p> <p>=====</p> <p>(Statute also allows agency to require access to records of energy used for pumping.)</p> <p>(Statute also allows groundwater management districts to impose measurement requirements.)</p>	
2c	Statute gives agency discretion to require measurement of water use.	<p>By ground water right holders who pump groundwater from wells with maximum pump capacity greater than 35 gallons per minute within a designated Active Management Area on a land area greater than 10 acres.</p> <p>=====</p> <p>(Statute also provides for a usage-based fee on groundwater water withdrawal/diversion to cover half the cost of the program with the other half coming from the state's general fund. Withdrawal fees can also be used for conservation assistance and augmentation projects such as groundwater recharge, as well as retirement of irrigated land.)</p>	<p>By any owner or user of a water right.</p>	<p>By all water users within a water measurement district, where the agency forms such a district.</p> <p>=====</p> <p>Statute allows users to form "ground water district" to promulgate their own measurement, recharge and mitigation plans where state has already imposed measurement requirement by formation of a "water measurement district."</p>
3	What is the mechanism for imposing measurement requirements on particular users or groups of users?	<p>Statute establishes three levels of water management (including measurement) to respond to different groundwater conditions.</p> <p>=====</p> <p>The agency assigns these designations to particular areas.</p>	<p>By Statute.</p> <p>=====</p> <p>By administrative order (applied to an individual or to an area).</p>	<p>By agency creation of "water districts" (where rights have been adjudicated) or "water measurement districts" (where there has been no adjudication but the agency believes measurement should be required).</p>
4	How is the particular manner in which measurement must occur specified?	<p>By regulations that specify methods and performance standards but not particular devices. The Agency now just relies on standards, having abandoned the approach of listing specific devices as being too burdensome administratively.</p>	<p>By Agency orders/rules subjecting particular geographic regions to measurement requirements and specifying the approach. In the Arkansas River Basin groundwater wells are required to be metered with totalizing flow meters or rated to determine a power coefficient (due to results of litigation over interstate compact compliance)</p>	<p>Agency lists or guidelines that are referenced in regulations and identify acceptable methods or devices.</p>
5	When required, where must measurement devices be located?	<p>Regulations require that approved measuring devices must be installed as close as possible to the wellhead, point of delivery, receipt, transportation, recharge, storage, replenishment, recovery, or use which the device is intended to measure, consistent with the manufacturer's instructions, and requiring measurement be at both the point</p>	<p>At point of intake of any irrigation ditch, canal, flume, or reservoir taking water from any stream.</p> <p>=====</p> <p>At point where transferred water leaves its natural watershed and point of final diversion for use from public stream.</p> <p>=====</p> <p>At certain other locations such</p>	<p>At point of diversion.</p>

Row Number		Arizona	Colorado	Idaho
		of pumping <i>and</i> the point of turnout to delivery to the farmer (not the property line).	that specified types of flows may be “definitely ascertained and determined.	
6	Reporting and data management.	Distinct reporting forms/worksheets are required for different measurement methods and devices.	User’s duty to construct and maintain measurement and control devices is distinguished from Agency’s duty to supervise and control the devices and to record and report measurements.	Requires reporting of maximum instantaneous flow rate and annual total volume. ==== By watermasters in water districts, “district hydrographers” in water measurement districts.
7	Issues (Problems, Constraints, Benefits)	Referred to number of points of at which measurement is required as increasing the staffing burden. (e.g., more individual rightholders more burdensome than measurement by collectives). ==== Referred to burdens of adopting a paper-heavy approach compared with accountability benefits of creating an audit trail. ==== Referred to fact that groundwater measurement equipment breaks down and farmers do not promptly check and repair, leading to agency preference for power consumption coefficient method.	Referred to staffing levels as limiting the number of points at which measurement can be required; current staffing level is adequate for the number of surface diversions, but limits the agency’s ability to expand the program to cover the more numerous groundwater wells statewide	Referred to staffing levels as limiting the agency’s ability to perform adequate data quality assurance. Referred to generally incompatible desires of numerous types of people for measurement that is simultaneously as inexpensive as possible and as accurate as possible. ==== Some lack of consensus/focus in the state regarding what is the purpose of the data being collected, and what will it be used for.
8	Theory vs. Practice	Measurement has not induced much conservation because the “flexibility account” system has generally allowed farmers to build up huge credits reducing the incentive for conservation.		

PRELIMINARY NARRATIVE SUMMARY**MEASUREMENT IN SELECTED STATES****ARIZONA****Who requires or provides incentives for water use measurement?**

There are no specific statewide standards or requirements pertaining to measurement of surface water use, with the exception of areas subject to active decrees. In Arizona, such areas include the Little Colorado River and Gila River systems. These areas, which include most of the state's surface rights, are subject to longtime decrees and are also presently undergoing general adjudications in the courts. Under the decrees, the courts have typically required users to measure and report diversions from natural streams into canals using weirs. It is anticipated that the results of the present adjudications will also include some form of measurement and reporting requirements. The Bureau of Reclamation also requires measurement of diversions from the Colorado River mainstem.

In 1980, the legislature passed the state Groundwater Management Code, and established the Arizona Department of Water Resources to administer the code. The Code establishes three levels of water management to respond to different groundwater conditions. The lowest level of management includes general provisions that apply statewide. The next level applies to Irrigation Non-Expansion Areas (INAs). Areas where groundwater depletion is most severe are designated as Active Management Areas (AMAs). The boundaries of INAs and AMAs are generally defined by groundwater basins, not political boundaries. Three INAs and five AMAs have been designated. The Department must prepare a series of five management plans for each AMA.

The Groundwater Management Code prohibits new irrigated acres within AMAs and INAs.

Rightholders who pump groundwater from wells with maximum pump capacity greater than 35 gallons per minute in an AMA must measure those withdrawals using an approved measuring device or method. Such rightholders must also report annual water withdrawal and use to the Department. The reports must be audited. Within an AMA, the report must be filed even if no water was pumped. Within an INA, only those who actually pumped water must submit a report.

Such rightholders also pay an annual groundwater withdrawal fee, which is used to offset half the cost of administering the Groundwater Management Code, with the other half coming from the state's general fund. Withdrawal fees can also be used for conservation assistance and augmentation projects such as groundwater recharge, as well as retirement of irrigated land. The

fee can vary from year to year but does not exceed five dollars per acre-foot of groundwater withdrawn.

Who measures water use?

Small properties (under 10 acres) are exempt from measurement requirements. Persons who use only surface water not subject to any decree are also exempt from measurement requirements.

Under Department regulations, measurement is to be conducted by any “responsible party” which is defined as “an irrigation district or a person required by A.R.S. Title 45, to use a measuring device or method approved by the Director.” (Arizona Administrative Code, § R12-15-901 (5).) More specifically, the regulations state that a “responsible party shall install an approved measuring device to monitor the volume of water withdrawn, delivered, transported, recharged, stored, replenished, recovered, and used.” (Arizona Administrative Code, § R12-15-902 (A).) In general, there need not be a separate measuring device for each right, unless specifically required in a particular case, but the number of measuring devices must be sufficient to allow for separate monitoring and reporting of volumes for five types of rights: 1. irrigation grandfathered rights; 2. non-irrigation grandfathered rights; 3. service area rights; 4. groundwater withdrawal permits; and 5. recovery well permits or water storage permits. (Arizona Administrative Code, § R12-15-902 (B).)

Where and how is water use measured?

Approved measuring devices must be installed as close as possible to the wellhead, point of delivery, receipt, transportation, recharge, storage, replenishment, recovery, or use which the device is intended to measure, consistent with the manufacturer’s instructions. (Arizona Administrative Code, § R12-15-902 (C).) The state requires that measurement be at both the point of pumping and the point of delivery to the farmer. The pumping is often done collectively, through a district. The state has learned that there is almost no way to get accurate measurement at the property boundary. Thus, they use the turnout instead, which is typically at the high point of 160 acres. To estimate measurement at the point of delivery to each right, the user provides an estimate based on pro rata share of the acres irrigated, or based on acres irrigated plus consumptive use of each crop grown.

Persons required to measure must use an “approved” measuring device with an approved measuring “method.” The Department formerly maintained a list of water measuring devices that meet the accuracy requirement of +/- 10%. (Arizona Administrative Code, § R12-15-905 (A).) The Department later abandoned the list approach, however. It proved too burdensome to keep up with technology, maintain the list and respond to requests to add things to the list (and complaints about things the Department had included). Now the Department just relies upon the performance standard.

To be approved, a device must also be installed, maintained, and used in accordance with the manufacturer's recommendations. (Arizona Administrative Code, § R12-15-903.)

Approved methods include: (1) totalizing measuring method; (2) electrical consumption measuring method; (3) natural gas consumption measuring method; (4) hour meter measuring method; (5) elapsed time of flow method. (Arizona Administrative Code, § R12-15-903.) Responsible parties can use alternative water measuring devices or methods if approved in advance by the Department, which the Department shall approve if they meet the accuracy requirements. (Arizona Administrative Code, § R12-15-909.)

Who reports, compiles, stores, distributes, and uses measurement information and how?

There are six different types of worksheets that must be completed and submitted to the Department by extractors of groundwater from wells within AMAs with capacities greater than 35 gallons per minute. The choice of worksheet depends on the type of meter or method used to calculate the volume of water pumped. Details of these reporting requirements are set forth in Arizona Administrative Code, section R12-15-904. The Arizona approach is relatively "paper heavy" compared with some other states, such as Kansas. The advantage of the worksheet approach is that it helps create an audit trail.

The data from the worksheets/reports is coded into the computer and yields an ability to identify well-by-well pumpage. There is an accuracy requirement for the reports, which is distinct from the accuracy requirement for the devices. The reporting standard gets tougher over time. Violations cannot be found unless the amount withdrawn exceeds the amount reported by 15% through 1989, 10% through 1999, and 8% through 2009. (Arizona Administrative Code, § R12-15-1003.)

The reported data are used in planning efforts, including the preparation of budgets of water use and trends, as well as flow models. The data are also used in compliance work, to ensure that persons take no more water than they are rightfully entitled to. Also, the data is used in computing the amount of tax owed by each groundwater user.

In a compliance mode, measurement information is used to calculate exceedances of amounts allowed through the state's system of "flexibility accounts." In AMAs, the limit of a person's rights to use groundwater is determined through a process involving a number of factors. First, the only lands that can be irrigated are lands that were legally irrigated between 1975 and 1979. For example, these so-called "irrigation acres" would be 1,000 acres for a farmer who owned 1,000 acres and irrigated all of them, 250 acres at a time, in a four year rotation. The "water duty acres" are the highest number of acres irrigated at any time between 1975 and 1979. Thus, if the same farmer irrigated every acre at least once during the relevant 5 years, his irrigation acres would be 1,000, and if he irrigated 500 of them in one of those years, his "water duty acres" would be 500. The "water duty" is the amount of water per year, expressed in acre-feet,

reasonably necessary to irrigate the crops historically grown on a given farm. Deriving the “water duty” involves an exercise in judgment, an understanding of crop irrigation needs, and a knowledge of what “reasonable conservation methods” are available to users. For each AMA, there are supposed to be five plans of ten years duration each. From plan to plan, the water duty tightens up in order to induce greater conservation, until the mid-point in the process, in plan 3, when the plans call for maximum efficiency.

Multiplying the “water duty acres” by the “water duty” produces the number of acre feet in the “maximum annual groundwater allotment.”

Users are not limited to their annual allotment. Rather, the amounts they use above and below the allotment go into a so-called “flexibility account” as debits and credits. The Department maintains such an account for each farm. In any given year, a user can use up to all of the credits accumulated in his or her account. Where those credits are insufficient, a farmer can borrow up to 50% of the maximum annual groundwater allotment. Thus, the Department would not deem a farmer to be out of compliance until the farmer was using more than 150% of the maximum annual groundwater allotment. Measurement of actual water use plays a role in this compliance/enforcement step, but does not play a significant role in the calculation of the allotment (with the exception of some historical data used to identify average irrigation use in the late 1970’s).

What are the purpose(s), benefits, and problems of this approach?

The two main purposes are to enforce water rights, and encourage conservation. In terms of operational changes that produce conservation, one staff person frames the goal as follows: to help farmers accurately know at what point to stop applying water. To fulfill this goal, one should understand: (1) when to irrigate, (2) how much to irrigate for a particular crop, and (3) when one has reached that point and should stop.

The primary management goal for the AMAs is safe yield by the year 2025. In the Santa Cruz AMA, where significant international, riparian and groundwater/surface water issues exist, the goal is to maintain safe yield and to prevent local water tables from experiencing long term declines. In the Pinal AMA, where a predominantly agricultural economy exists, the goal is to allow the development of non-irrigation water uses, extend the life of the agricultural economy for as long as feasible, and preserve water supplies for future non-agricultural uses.

The management goal in INAs is to prohibit the expansion of acreage irrigated with groundwater. The Groundwater Management Code restricts irrigation to land that was irrigated in the five years prior to an area’s designation as an INA.

The administrative burden on the agency has not been very unreasonable regarding wells, one staff person reports. Regarding individual users/rightholders, however, the agency confronted substantially larger costs.

Does actual practice live up to intended policy incentives or legal requirements?

According to one staff person, “Theory and practice have been very far apart.” There has been significantly less use than provided for in the allotments. As a result, farmers have built up huge numbers of credits in their flexibility accounts. This has substantially limited the incentive for conservation derived from the planning process.

The main rule that drives conservation has instead been the rule that, for every additional acre-foot of surface water used, groundwater must decrease by one acre-foot. In other words, as long as one pumps some groundwater, one’s maximum annual allotment is calculated in such a way that substitute supplies cannot be added to one’s pumping. This serves the policy goal of decreasing the burdens on the groundwater system. The only way to escape this rule is to use no groundwater at all, which would take one’s use outside of the measurement and reporting requirements altogether.

One staff person reports that the agency prefers the electric consumption method of measuring. Water meters break down and the farmers do not check them or repair them. Whereas electricity meters almost never break, and the power company collects the data. If an electricity meter works, he says, it is usually within +/- 2% in accuracy.

COLORADO**Who requires or provides incentives for water use measurement?**

The state legislature has enacted statutes providing for measurement of surface and groundwater. The state Division of Water Resources (also known as the Office of the State Engineer) implements these statutes. State law gives general authority to the Division of Water Resources to administer, distribute and regulate the waters of the state. (Colorado Revised Statutes, § 37-92-501 (“CRS”).)

Who measures water use?***Any Owner or User of a Water Right May be Required by Administrative Order to Measure Water Use.***

Under state law, the Division of Water Resources has a set of general authorities to require measurement by means of administrative order. The State Engineer is authorized to order any owner or user of a water right to install and maintain at the owner’s or user’s expense necessary meters, gauges, or other measuring devices and to report at reasonable times to the appropriate Division Engineer the readings of such meters, gauges or other measuring devices. (CRS, § 37-92-502, subd. (5).)

Also, the “state engineer and the division engineers have authority to order any person or company supplying energy used to pump ground water to provide, at reasonable times to the appropriate division engineer, records of energy used to pump ground water.” (CRS, § 37-92-502, subd. (5)(a) & (b).)

Measurement is Required by Statute at Specific Points in the System.***Surface Water***

In regard to surface water, state law distinguishes between the duty to construct and maintain and the duty to supervise and control a measurement device.

The Duty to Construct and Maintain

The duty to construct and maintain measuring devices falls on several different categories of people.

- “The owners of any irrigation ditch, canal, flume, or reservoir in this state, *taking water from any stream*, shall erect where necessary and maintain in good repair, at the point of intake of such ditch, canal, flume, or reservoir, a suitable and proper headgate of height

and strength and with embankments sufficient to control the water at all ordinary stages *and suitable and proper measuring flumes, weirs, and devices* and shall also erect and maintain in good repair suitable wastegates where necessary in connection with such ditch, canal, flume, or reservoir intake.” (CRS, § 37-84-112, subd. (1) (emphasis added).)

- “The owners of any irrigation ditch, canal, or reservoir, transferring water from one natural stream to another, or from a reservoir, ditch, or flume to a stream in order that said water may be diverted from such stream for irrigation or any other purpose, shall construct suitable and proper measuring flumes or weirs, equipped with self-registering devices if required by the state engineer, for the proper and accurate determination of the amount and flow of water turned into, carried through, and diverted out of said natural stream.” (CRS, § 37-84-113 (emphasis added).)
- “The owners of any *reservoir situate upon or in the bed of any natural stream or through which any natural stream flows, for the purpose of storing or diverting water . . .* at the expense of such owners and under the supervision and with the approval of the state engineer, shall construct and permanently maintain a suitable and permanent measuring weir or flume equipped with self-registering devices, according to plans and specifications approved by the state engineer, in the bed and channel of every natural stream or watercourse discharging waters into said reservoir by means of which all of the water flowing into said reservoir from and through each such stream or watercourse, at all times may be definitely ascertained and determined.” (CRS, § 37-84-117 (emphasis added).)
- In regard to water transfers, anyone “*transferring water from one public stream to another* is required to construct and maintain, under the direction of the state engineer, measuring flumes or weirs and self-registering devices at the point where the water leaves its natural watershed and is turned into another and also at the point where it is finally diverted for use from the public stream.” (CRS, § 37-83-102 (emphasis added).)
- Similar requirements are imposed where the owner of a *reservoir delivers stored water into a ditch or into the public stream and takes in exchange water from the public stream higher up.* (CRS, § 37-83-104.)

The Duty to Rate

Officials from the Division are required to “rate” the measuring flumes and weirs. (CRS, § 37-84-114.) When they are trying to rate a weir, or flume, or measuring section of a canal, it is a misdemeanor for the diverter to fail to adjust flow to enable that rating. (CRS, § 37-80-11.)

The Duty of Supervision and Control

“All headgates, measuring weirs, flumes, and devices used in connection with canals, flumes, and ditches or reservoirs for the measuring and delivering of waters therefrom and thereto shall be under the supervision and control at all times of the state engineer and the division engineer of the water division wherein such headgates, measuring weirs, flumes, and devices are located.” Any water user is allowed to read any gauge, gauge rod, or measuring device or determine the quantity of water diverted by any canal or impounded in or delivered from any reservoir. (CRS, § 37-84-116.)

The allocation to the government of authority to supervise and control the measurement device is counterbalanced by the threat of criminal sanctions against the responsible official. “Any division engineer, or his deputy or assistant, who willfully neglects or refuses, after being called upon, to promptly measure water from the stream or other source of supply into the irrigating canals or ditches, in his division, according to their respective priorities, to the extent to which water may be actually necessary for the irrigation of lands under such canals or ditches, is guilty of a misdemeanor and, upon conviction thereof, shall be subject to [a penalty set forth in statute].” (CRS, § 37-84-122.)

Ground Water

State law allows for the formation of groundwater management districts, whose boards of directors are authorized to impose controls or regulations after consultation with users and the state Ground Water Commission. (CRS, § 37-90-131.) The control measures and regulations can include provisions “to prescribe satisfactory and economical measuring methods for the measurement of water levels in and the amount of water withdrawn from wells and to require reports to be made at the end of each pumping season showing the date and water level at the beginning of the pumping season, the date and water level at the end of the pumping season, and any period of more than thirty days cessation of pumping during such pumping season.” (CRS, § 37-90-131.)

Other

There is no statutory requirement that deliveries by diverters to farms within water districts be reported. As to measurement at turnouts to individual users, “It is the duty of those owning or controlling [of any canal or ditch used for irrigating purposes] to appoint a superintendent, whose duty it is to measure the water from such canal or ditch through the outlets to those entitled thereto, each according to his pro rata share.” (CRS, § 37-84-120.) Numerous districts measure such deliveries anyway for billing purposes. Some districts are more lax in measuring deliveries, using merely flow “time” as an indirect or surrogate measure for actual volumes delivered.

Where and how is water use measured?

Water use is measured at the locations described above.

Sometimes the Division itself measures flows at a point where tailwater returns to the public stream. This is done in order to identify areas where steps might need to be taken to curb excessive extraction or tailwater. More typically, this determination is made based on just visual inspection of the tailwater flows. That is, measurement or visual inspection at the point of return flow to the water source is used to flag promising areas for further inquiry as to conservation potential.

The state consists of numerous water basins. For measurement purposes several basins along the western side of the state are clustered together into the Colorado River region, such that the entire state is conceptualized as four regions: (1) the Colorado River region; (2) the Rio Grande region; (3) the South Platte region; and (4) the Arkansas region.

Groundwater measurement requirements vary by region. In the Colorado River region, there is no significant groundwater, and accordingly no requirement for measurement. The Rio Grande region has three major aquifers. There, groundwater withdrawals are estimated, but no actual extraction data is collected.

In the Arkansas River region, groundwater withdrawals are required to be metered with totalizing flow meters, pursuant to the outcome of litigation to enforce the Arkansas River Compact. (Amendments to Rules Governing the Measurement of Tributary Ground Water Diversions Located in the Arkansas River Basin, Feb. 28, 1996, rule 3.) If a totalizing flow meter is not used, the well must be rated to determine a power coefficient. The required level of accuracy is +/- 5%. If the meter is not operational, water is not allowed be pumped unless a specific backup water measurement program approved by the State Engineer is put into effect. The State Engineer is empowered to grant variances from these requirements in circumstances where strict application of the rules would cause “unusual hardship.”

In the Arkansas River region, irrigation diversions of ground water tributary to surface streams are subject to special rules requiring Division approval of a plan for replacement of usable flow at the state line with Kansas. (Amended Rules and Regulations Governing the Diversion and Use of Tributary Ground Water in the Arkansas River Basin, Colorado, Sept. 27, 1995, Rule 3.) As part of these rules, well users are required to furnish monthly records to the division engineer of the amounts diverted pursuant to the plan. If the well is powered by electricity, the user must authorize the power supplier to provide monthly power records to the division engineer. (Id., at Rule 12.) The state and division engineer must regularly tabulate diversions of ground water from the aquifers and make the tabulations available to the public; the tabulations must be summarized annually.

Who reports, compiles, stores, distributes, and uses measurement information and how?

The Division of Water Resources receives the data. In some parts of the state, on some water sources, use data is recorded in 15 minute intervals and compiled hourly. Thus, it nearly approximates real-time reporting. The data is compiled by the Division and published in annual reports.

In the Arkansas River region groundwater data is compiled on an annual basis, running from November 1 to October 31. Reports must be filed with the Division Engineer no later than January 31 of the following year.

The Division is presently developing a complex computer-based decision support system (i.e., the “Colorado Decision Support System” or “CDSS”) to manage and make use of the data.

What are the purpose(s), benefits, and problems of this approach?

Principal purposes of measurement pointed to by state officials include:

- monitoring water use to ensure that it is in accordance with water rights.

State officials also pointed to:

- limiting waste of water;
- improving water management;
- providing water right owner with an official record that can be certified to the courts, providing a basis for proving historic use in a change of water right case or sale of water right; and
- helping Colorado to meet interstate compact requirements.

Does actual practice live up to intended policy incentives or legal requirements?

In regard to surface water, a senior Division official reports that practice lives up to the intended policy objectives. This, he says, is a function of the fact that the Division has adequate staffing relative to the number of surface diversions that need to be addressed by the measurement regime. In regard to groundwater, however, there are thousands of individual wells that would require much greater staffing levels to adequately address. Thus, the agency is more reluctant to undertake groundwater measurement requirements where none now exist, unless adequate staffing levels are available.

IDAHO**Who requires or provides incentives for water use measurement?**

Pursuant to state statute, “appropriators or users of any public waters of the state of Idaho shall maintain to the satisfaction of the director of the department of water resources suitable headgates and controlling works at the point where the water is diverted. . . . Each such appropriator shall construct and maintain, *when required by the director of the department of water resources*, a rating flume or other measuring device at such point as is most practical in such canal, ditch, wellhead or pipeline for the purpose of assisting the watermaster or department in determining the amount of water that may be diverted into said canal, ditch, wellhead or pipeline from the stream, well or other source of public water.” (Idaho Statutes, § 42-701(1)(emphasis added); see also § 42-703 (regarding measurement devices along/in streams).)

In 1994, in the wake of various conflicts between water users in southern and eastern Idaho during the drought that began in 1987, the legislature amended state law to require the measurement of groundwater diversions and reporting of volumes withdrawn to the Idaho Department of Water Resources.

The state has a complex set of districts involved in water management. The measurement requirements in the state are generally carried out through the district system.

State law requires the Department to create “water districts” for areas in which a court has adjudicated water rights. Measurement requirements are typically part of the court’s decree. For each water district there is a “watermaster” who is nominally a state employee, but who is elected and compensated directly by district water users. Thus, watermasters are relatively autonomous compared with some other states such as Oregon. There are more than 100 water districts in Idaho.

State law also authorizes the Department to create “water measurement districts” to accomplish measurement and reporting outside of established water districts. There are three such districts in the state, in which most ground and surface water diversions must be measured and reported and members of the district are assessed for the costs of this work. These are located in the Eastern Snake River Plain Aquifer.

State law also enables ground water users to petition to organize “ground water districts” the creation of which removes an area from a measurement district. A ground water district can do all that a measurement district can do, plus it can develop and operate mitigation and recharge plans as well as represent their members in various legal matters. There are six such districts in the state. Such districts cannot be formed until they have submitted and the Department has approved a plan to implement water measurement over three years.

There is a wide range of measurement practices across the various districts in the state. The Department is in the process of developing statewide measurement guidelines in order to enhance uniformity across the various types of districts.

Who measures water use?

Within measurement districts, a “district hydrographer” carries out the measurement function. “At the meeting of the appropriators or water users of a district there shall be elected a qualified district hydrographer for such water measurement district, who may be authorized to employ such other qualified regular assistants as the appropriators or water users shall deem necessary, and who, upon qualification and appointment by the director of the department of water resources, shall be responsible for measurement of water as . . . required within the water measurement district, and the appropriators or water users shall, prior to the election of such district hydrographer and approval of the employment of assistants, fix the compensation to be paid them during the time actually engaged in the performance of their duties.” (Idaho Statutes, § 42-707(3).)

Where and how is water use measured?

Points of diversion that are subject to measurement and reporting requirements must have a Departmental “site identification tag” and be located by latitude, longitude, and elevation.

For surface water, the Department’s draft Guidelines have identified nine “standard” open channel measuring devices including:

- Suppressed rectangular weir
- trapezoidal flume
- contracted rectangular weir
- Parshall flume
- Cippoletti weir
- submerged orifice
- 90 degree V-notch weir
- constant head orifice
- ramp broad crested weir

The draft Guidelines also provide that the Department may authorize use of non-standard devices or rated sections provided the device or sections are rated or calibrated against a set of flow measurements using an acceptable open channel current meter or a standard portable measuring device.

For groundwater, there are two approaches described: (1) totalizing flowmeters or (2) electrical power consumption coefficient calculations (“PCC”). Devices are required unless they would be

“burdensome” for the water user, in which case the user must execute an agreement with the Department regarding use of the PCC approach. The PCC unit is the number of kilowatt hours required to pump one acre-foot of water.

A USGS study showed generally that PCC may be an acceptable surrogate for flowmeter measurements. However, there are some caveats to that generalization. First, where water levels fluctuate, PCC may not be a good surrogate. Second, where the pumping system is complex, PCC may not be a good surrogate. That is, it works well where a single electrical power meter is dedicated to one pumping plant. Where the system has a variety of valves, discharge locations, or distinct flows and pressures, the agency feels it should be more inclined to require flow meters. Notwithstanding this feeling, the agency has backed off the requirement of flowmeters in some cases because of a sense that users purchase lower quality meters, do not calibrate them well, and do not maintain them properly over time. (Winter weather is also somewhat hard on the meters.)

A time clock method is also sometimes used on constant flow systems.

Who reports, compiles, stores, distributes, and uses measurement information and how?

Upon written notice from the Department, users required to measure and report must annually report, among other things, the maximum rate at which diversions have been made during the reporting period, the total volume diverted during the reporting period, and a description of the physical changes to the diversion works that have been made during the reporting period. (Idaho Statutes, § 42-701(1).)

In water districts, “All watermasters shall make an annual report to the department of water resources prior to the expiration of the watermaster's appointment for the current year. This report shall show the total amount of water delivered by the watermaster during the preceding year, the amount delivered to each water user, the total expense of delivery and the apportionment of expenses among users and all debits and credits to be carried over to the following year. Such report shall also include records of stream flow the watermaster used or made in the process of distributing water supplies.” (Idaho Statutes, § 42-606.)

In water measurement districts, “All district hydrographers shall make and certify annually a report to the department of water resources, in a form and containing the information required by the director of the department of water resources, prior to the expiration of the district hydrographer's appointment for the current year. This report shall show the amount of water diverted at each diversion as measured or determined by the district hydrographer during the preceding period from November 1 through October 31, the total expense of the district and the apportionment of expenses among users and all debits and credits to be carried over to the following year. Such report shall also include records of stream flow, depth to ground water measurements, current names and addresses of appropriators or water users within the district

and such other information as the district hydrographer collected or caused to be collected in the course of completing the duties of the district as instructed by the director.” (Idaho Statutes, § 42-708.)

What are the purpose(s), benefits, and problems of this approach?

According to a Department staff member, the principal purpose is to ensure delivery of the correct amounts by the watermaster. The main benefits include protection of the users’ rights by reliably documenting various uses. This is helpful in circumstances involving adjudications as well as transfers (where the agency needs to resolve public protests or limit the transfer). The data is also helpful in ensuring and demonstrating compliance with interstate compact requirements. In this sense, the main purpose is regulatory. In addition, the effort contributes to planning and scientific work relating to statewide water resource management. For example, they have combined use data with satellite data to prepare estimates of evapotranspiration.

In one study, state officials learned that 30-40% of groundwater diversions were exceeding rightful levels.

There tends to be a difference of opinion between the groundwater users and surface users. The groundwater users tend not to care about volumes of water withdrawn since they believe that much of their withdrawals are recharged. Thus, they are more concerned about water levels. At the same time, surface users tend to be concerned about rates of diversion/withdrawal because this may indicate a source of interference with downstream water rights. Thus, surface users are more likely to desire flow meters for upstream users.

Does actual practice live up to intended policy incentives or legal requirements?

According to one Department staff person, “measurement is not often a precise science or activity.” Everyone wants measurement to be, at the same time, as cheap as possible and as accurate as possible, and those things do not go together.

The state has struggled with the questions of what is the purpose of the data being collected, and what will it be used for. As a result, one Department staff person offers the advice that “You’ve got to define your objectives first.” That then drives the “level of accuracy” desired. And that, in turn, dictates the specific technical approach to measurement. For example, he says, if you decide that you only need accuracy of +/- 15 %, you don’t need meters, whereas a desired accuracy level of +/- 3 % may necessitate the use of meters.

Agency staff have concerns about the accuracy of the data they receive through user measurement. Engaging in quality assurance over that data is a separate and substantial step in the measurement process. In Idaho, agency staff have done only a little field-truthing, which is a

time consuming and costly process. Also, there is some problem with the timeliness of reporting.

Agency staff do not get involved in reading or calibrating meters.

KANSAS

Who requires or provides incentives for water use measurement?

The legislature has enacted just two concise statutes. In 1957 the legislature enacted a law stating that “The chief engineer shall have full authority to require any water user to install meters, gages, or other measuring devices, which devices he or she or his or her agents may read at any time, and to require any water user to report the reading of such meters, gages, or other measuring devices at reasonable intervals. He or she shall have full authority to make, and to require any water user to make, periodic water waste and water quality checks and to require the user making such checks to report the findings thereof.” (Kansas Statutes Annotated, § 82a-706c.) In pursuit of this mandate, use information was initially collected based on estimates of flow rates and estimates of hours pumped. It was determined that those estimates were not accurate enough in certain situations.

Beginning in the 1980’s the Chief Engineer and certain Groundwater Management Districts began requiring water flowmeters in some cases.

In 1988 (amended in 1991) the legislature enacted legislation stating that “The owner of a water right or permit to appropriate water for beneficial use, except for domestic use, shall file an annual water use report on a form prescribed by the chief engineer of the division of water resources of the state board of agriculture on or before March 1 following the end of the previous calendar year. The report shall completely and accurately set forth such water use information as requested by the chief engineer.” (Kansas Statutes Annotated, § 82a-732.)

The Kansas Department of Agriculture, Division of Water Resources, has enacted regulations implementing the reporting requirement. Since 1988, the Division has required metering of water use together with reporting.

Who measures water use?

Pursuant to statute, all permitted water users, including irrigation, are required as a condition of their permits to maintain accurate records from which the quantity of water diverted each calendar year may readily be determined.

The Kansas Department of Agriculture has required approximately 600 water flowmeters per year. The Chief Engineer has so far required about 10,700 meters. There are about 30,000 permits in the state.

All “nondomestic, nontemporary wells and pump sites operated under the authority of an approval of application issued on or after the effective date of [the] regulation shall be equipped

with a water flowmeter that meets or exceeds the” agency’s requirements. (Regulations of the Dept. of Agriculture, Division of Water Resources, § 5-1-7(a).)

All “nondomestic, nontemporary gravity diversions of water, including irrigation ditches, operating under the authority of an approval of application issued on or after the effective date of this regulation shall be equipped with a continuous recording gauge, or other suitable water-measuring device located at or near the headgate. Before installation, the water right owner shall submit plans and specifications for the proposed gauge, or other suitable water-measuring device, to the chief engineer and shall receive approval in writing from the chief engineer before installing the gauge or other suitable water-measuring device.” (Regulations of the Dept. of Agriculture, Division of Water Resources, § 5-1-7(b).) The gauge or measuring device must be accurate to +/- 6%.

Anyone who changes any condition on their water right permit has a further condition added requiring measurement. Any additional administrative action on the permit leads to a metering requirement.

Where and how is water use measured?

In the Southwest part of the state all owners of water rights or holders of permits must have a meter. Elsewhere everyone must have a meter only where the Chief Engineer finds that special conditions exist. The areas in which metering has been imposed are all areas where groundwater is a particular concern. However, the state recognizes the interaction between surface and groundwater. Accordingly, the metering requirement is sometimes imposed partially to protect senior surface rights that rely upon base flow in a stream.

There are no statutes or regulations setting forth criteria that the Chief Engineer must or will use in deciding that an area needs measurement. The Chief Engineer has broad discretion. Typically, though, it is done where there is a need to: (1) protect the water source (e.g., reduce depletion of an aquifer), or (2) protect senior water rights from impairment.

When required, the flowmeter must be certified by the manufacturer to register within +/- 2% accuracy. There is a very strong emphasis in the regulations on manufacturer quality assurance, as well as proper installation and maintenance. The manufacturer of the flowmeter is required to have an effective quality assurance program, including wet testing a random sample of its products, and to certify this to the state Chief Engineer. The regulations specify further standards that flowmeters must meet, including for example, requirements for weatherproof registers readable even when the system is not operating, flow straightening vanes (except in limited circumstances), totalizers that will not cycle past zero more than once per year, and other specific requirements. Variances from these requirements are available in specified circumstances. (Regulations of the Dept. of Agriculture, Division of Water Resources, § 5-1-4.) The regulations also contain very detailed flowmeter installation requirements.

The chief engineer maintains a list of all makes and models of water flowmeters that have been certified by the water flowmeter manufacturer to meet the specifications of the chief engineer.

Who reports, compiles, stores, distributes, and uses measurement information and how?

Water use reports are required annually. There is a cooperative division of labor between the Division of Water Resources (which handles water rights issues) and the Kansas Water Office (which is the state's water planning agency). Initially, the Division enforces the measurement and reporting requirement and enters the data into the computer system. The Water Office then compares the data to existing standards and makes sure the data is consistent with known typical water uses for various beneficial uses.

The Water Office kicks out a list for joint follow up by the Water Office and the Division, including for example instances where users reported unreasonable values given what is known for uses of that type. The agencies follow up together in contacting the user to clarify the numbers, submitting follow up letters and making phone calls to clarify information reported.. The report is then fixed and the "clean" data is included in the database used for planning and other purposes. Members of the public can access the final database by request, and will see the clean figures; or, if they want, they can obtain the whole file through freedom of information requests, and see any edits that have been made as a result of the agency's data quality control efforts.

What are the purpose(s), benefits, and problems of this approach?

The main purpose of the effort is "water management." The agencies want the data to help identify the state's priorities. They want to know: "Where are we short? Where are we misusing? Do we have enough for the future? Do we have plans for making sure resources are available?" Using the water measurement information that is collected, the Water Office periodically reflects actual use in its plans, and the Chief Engineer revises its standards for what is a "reasonable" maximum use of water for particular types of beneficial uses. The Division of Water Resources then incorporates those amounts into all new permits as maximum amounts at time of permit issuance. After perfection and an administrative process to finalize the right, the right is limited to actual use demonstrated. Water rights enforcement is thought of as a subset of water management.

The purposes include effective administration of water rights to prevent impairment, to protect minimum desirable stream flows, to conserve water, or to otherwise carry out the duties of the chief engineer as set forth in statutes. (See, e.g., Regulations of the Dept. of Agriculture, Division of Water Resources, § 5-1-7(f))

The cost of testing the Department's own 20 flowmeters for accuracy is about \$2,000 per year. The average cost for an irrigation water flowmeter on a new well or pumphouse is approximately \$1,000, including installation. Proper annual maintenance, including annualized replacement costs is estimated to be \$75 per meter for the 10,700 meters that have been required by the chief engineer. Flow straightening vanes and measurement tubes add about \$100 per meter to the cost of the flowmeters. Non-agency personnel are not required to test flowmeters, but if they do, they will initially incur approximately \$1,000 to \$5,000 to obtain proper testing equipment and training. They would also incur \$200 to \$500 annual cost to have their equipment certified to be accurate.

Initially, the emphasis on manufacturer quality assurance engendered some resistance from the device industry. A small number of manufacturers have sub-standard measuring products and they did not do well under this system. As a result, retailers generally do not offer some of the cheap and low quality meters that are not on the agency's list. This has helped to avoid the problem of people buying the cheapest product and not caring whether it provides accurate measurement.

Does actual practice live up to intended policy incentives or legal requirements?

About 33 percent of irrigators do not use water meters and many of them had difficulty providing accurate data on the number of hours pumped, and they generally had even more difficulty in providing current data on pumping rates.

Overall actual practice lives up to the intended policy. According to one staff person, metering is a direct method of measuring water use. If the meter works, and it's accurate, then you're getting good numbers. If it's a reliable meter from a good manufacturer, and it is kept well maintained, from an enforcement perspective it is very "straightforward." As a result it is felt that people can manage their water better.

OREGON

Who requires or provides incentives for water use measurement?

Pursuant to state statute, the Oregon Water Resources Department is responsible for requiring and providing incentives for measurement. According to Department staff, in the last legislative session, a statute was enacted that nominally established a fund from which the Department can match monies needed for installation and maintenance of measurement devices. As of early September 2001, the fund had no balance. By law, the Department will be able to receive monies by grant and donation, if any.

The Water Resources Commission, an appointed citizen body that oversees the Department, may require the owner of any ditch or canal to construct and maintain “suitable measuring devices at such points along the ditch as may be necessary to assist the watermaster in determining the amount of water is to be diverted into the ditch from the stream, or taken from it by the various users.” (Oregon Revised Statutes, § 540.310 (“ORS”).) Headgates *are* required; measuring devices and flumes *may be* required.

It is the norm, not the exception for there to be a watermaster. There are twenty watermasters statewide for the twenty Department districts.

Since 1993, in responding to applications for new water rights, the Department has routinely included permit conditions concerning measurement and reporting. These conditions either require measurement and reporting or allow the Department to require it under the terms of the permit if necessary in the future. For small diversions, the permits say that neither measurement nor reporting is presently required but either or both may be someday. For medium diversions, the permits say that measurement is required now and reporting may be required someday. For large diversions, the permits say that both measurement and reporting are required now.

When a permit condition provides for the possibility of future measurement, the Department invokes that provision by posting a “headgate notice.” The Department posts approximately 5 or 6 headgate notices per year requiring measurement devices. If the owner of an irrigation works refuses or neglects to put in required headgates, flumes or measuring devices, the local Watermaster from the Department can close the ditch. (ORS, § 540.320.)

Owners and managers of reservoirs on natural streams must install measuring devices above and below the reservoir. (ORS, § 540.330.) If the owner or manager of the reservoir fails to comply, the Watermaster can open the outlet to the reservoir. (ORS, § 540.330.)

The Commission may adopt a rule to designate an area as having “serious water management problems” and order affected water right holders to submit annual water use reports in that area. (Oregon Administrative Rules, § 690-085-0020 (1).) A variety of circumstances can give rise to

such a designation including, for example, frequent water management disputes that cannot be privately resolved, substantial interference between wells, frequent water shortages, and other circumstances. (Oregon Administrative Rules, § 690-085-0020 (1).) Petitions proposing designation of an area should include a proposed program describing “any measuring devices to be required, information which would be submitted on any annual water use reports and proposed procedures for regulation of water use.” (Oregon Administrative Rules, § 690-085-0020 (3).) The adopted rule must specify “the nature of the problem, the boundaries of the area involved, who is required to install measuring devices, specifications for the types of measuring devices and annual reports, and timelines for implementation.” (Oregon Administrative Rules, § 690-085-0020 (6).) The provisions regarding serious water management problem areas are on the books, but have never been used.

Under the “Oregon Plan for Salmon and Watersheds” numerous agencies have committed to measures for improved management of the state’s aquatic resources, including steps that can help increase instream flows. The Water Resources Department has committed to a measure called “WRD 20—Water Use Measurement and Reporting,” which has been assigned a “high priority” status. Summarized, WRD 20 calls for: (1) expediting entry of water use data into the Department’s database and flagging of reports for quality assurance purposes; (2) inventorying significant diversions to ensure adequate headgates and measuring devices and helping users with improvements; (3) helping public entities improve measurement programs and data quality; (4) providing the Commission with any needed recommendations regarding proposed designations of “serious water management problem areas”; and (5) monitoring effects of such designations on water use and streamflows, and if such designations show effectiveness at increasing streamflows considering further designations. Staff are carrying this effort out incrementally over time, focusing initially on compliance with measurement requirements at “significant diversions” (e.g., greater than 5 cubic feet per second).

Who measures water use?

Under existing law, governmental entities must measure water use. Private entities may be required to do so, either individually or as part of a group within a designated geographic area where measurement is required.

Water use measurement has been required for public users since 1987. (ORS, § 537.099.) “Any governmental entity that holds a water right” (i.e., cities, counties, irrigation districts, federal agencies and others) has been required to measure to 15% accuracy and report to the Department once each year.

Also, the Department has been imposing on selected individuals permit conditions to require measurement. The Department has broad authority to impose such conditions under a statutory provision stating that water rights permits “shall set forth any terms, limitations and conditions as the department considers appropriate.” (ORS, § 537.211.) The individuals chosen to be subject

to measurement requirements are chosen on the basis of size of diversion or existence of special circumstances warranting measurement.

Where and how is water use measured?

The Department's regulations set forth numerous approaches that meet the required degree of accuracy. The regulations further provide that all methods must be approved in advance by the Department, except those already approved in the regulation. Alternative methods can be used if a registered professional engineer certifies to the Department that the method will report use to the required degree of accuracy. (Oregon Administrative Rules, § 690-085-0015.)

Who reports, compiles, stores, distributes, and uses measurement information and how?

Approximately 800 entities presently report to the Department. By the end of each year, any governmental entity holding a water right must submit to the Department a report of monthly volume of water use for each major use at each point of diversion over the past year (i.e., October 1 to September 30). (Oregon Administrative Rules, § 690-085-0010 (1).) The accuracy of the reports must be +/- 15%. (Oregon Administrative Rules, § 690-85-0010 (3).)

Under limited circumstances, the user/governmental entity is allowed to assume that the monthly use is the maximum allowed under the right and permit, and may report that volume. Such circumstances include where the Department has approved a time extension for compliance due to economic hardship. (Oregon Administrative Rules, § 690-85-0010 (4).)

The Commission may waive compliance with the accuracy standard and the prescriptive measurement methods set forth in the administrative rules, in a case where there would be an economic hardship and where the information collected "would not materially aid water management." (Oregon Administrative Rules, § 690-85-0010 (6).)

Over the past ten years the Department has put in place a data management system, which incorporates rights data, gauging data, and reports of water use. An agency official reports that the data is posted to the agency website, but the agency has been slow to get it posted. This is due to staffing shortages combined with a desire by the agency to post the data only after it has gone through a quality assurance check. The agency has used the data in developing its statewide water availability model. The USGS has also used it in developing their 5-year water use reports.

What are the purpose(s), benefits, and problems of this approach?

Staff indicate that they have drawn a sharp distinction between two broad purposes: (1) prevention of "waste"; and (2) improved efficiency. This distinction is important, they feel, because while efficiency is good, waste is illegal. That is, it is unlawful to use water in a manner

that exceeds one's permitted rights. Since waste is illegal, there is little need to discuss it. It is basically assumed by everyone that the agency has an appropriate role in reducing illegal use of water and that measurement can contribute to that. As a result of this distinction, their public discussion and debate has focused on the purpose of improving efficiency and the best ways to do that. Also, they generally believe that bigger savings are available through improved efficiency than through enforcement (e.g., looking for potential locations for canal lining rather than looking for people using sprinkler systems to water pavement).

In articulating a proposed future strategy to the Commission, agency staff identified the following purposes for measuring water use:

- The information can benefit water right holder's by increasing awareness of the amount of water they use and providing the basis for self-regulation.
- Measurement data may be used by water right holders to develop improvements in their business operations and to plan for present and future needs.
- Water use data can provide reliable evidence for water right holders to rebut allegations of forfeiture for non-use.
- Water measurement information assists the watermaster in the effective distribution of water in accordance with the rights of record.
- Water measurement provides scientific data that can help Oregon Plan recovery efforts by providing accurate information to help with streamflow restoration projects or improve water distribution efforts.
- Water measurement data is important to help staff update and refine the water availability model, and develop other needed technical analyses that are the basis of fair and sensible management decisions.

In articulating the purposes in a more specific fashion, related to particular agency programs, staff identified the following purposes:

- Water measurement data is used to refine and update our water availability model, which is used to evaluate whether new water right permits may be issued.
- Water use measurement data provides information for use as final proof evidence for water right certification.

- Historical water use data is used to support injury determination for proposed water right transfers, permit amendments, exchanges and voluntary instream leases.
- Water use information is important to support projects to improve water use efficiency and projects to conserve water under the Allocation of Conserved Water program [under which users may get to keep some water that they conserve].
- Water measurement information supports Department actions to distribute and regulate water use for the protection of senior water rights.
- Water measurement data is used to help staff monitor instream water rights and flows, and to monitor the effects of streamflow restoration projects.
- Water measurement information can act as an early warning system for catastrophic flood events.
- Measurement data is used to coordinate water release schedules for stored water.
- Water use measurement information is important to monitor the status of critical ground water areas.
- Measurement and reporting data is central to the purposes of the Annual Water Use reporting program, which affects public water users.
- Generally, lack of accurate measurement data in these program areas does not prohibit staff from carrying out their responsibilities. However, as issues related to water use become more complicated, and the competition over remaining available water resources intensifies, water use-related actions will be subject to increasing scrutiny and challenges. Water measurement information provides a firm foundation for staff to make good decisions in implementing Department programs.

Does actual practice live up to intended policy incentives or legal requirements?

The policy and legal requirements presume that people will willingly participate, willingly maintain measurement devices, understand what is required, and willingly meet the accuracy standard. An agency official reports that “some people will comply when it is in their interests, but most users will not and would just as soon not share their information with anyone.” Where the agency has required measurement by permit condition they have less than a 50% compliance rate.

An agency official reports that “a voluntary program, without quality assurance monitoring, does not work. A good measurement and reporting program takes a lot of resources.”

An agency official further reports that staffing levels are insufficient to assure compliance with the measurement requirement and the requirements regarding the degree of accuracy needed in measurement devices. They regard their own staffing levels for field staff as being substantial, but still insufficient (approximately 55 to 60 people). It is an enormous undertaking, one official reports, and a particular challenge to ensure data quality.

Their experience does confirm that people use less water when it is measured. Staff has looked at a couple of areas of the state and know that water use went down. The agency has never formally written up these findings, though.

An agency staff person reports that there is a common misperception that there is a “magic way to measure” whereby one can easily just install a standard piece of technology once and the data somehow “just comes back to your computer.” There is often an insufficient appreciation of the fact that measurement of agricultural water use involves a labor intensive and ongoing effort involving construction of weirs, gauging stations, flumes, meters, and controls, and that there is a professional exercise of technical judgment needed in constructing and rating these.

WASHINGTON STATE**Who requires or provides incentives for water use measurement?**

The state Legislature has adopted a statute that requires measurement of water use in specified circumstances. (Revised Code of Washington, § 90.03.360.) The state Department of Ecology is charged with implementing the statute. The Department is currently in the process of issuing new regulations to implement the statute.

Who measures water use?

State law enacted in 1993 requires measurement of water use by any “owner” of “any water diversion.” State law requires the Department of Ecology to enforce the requirement for measurement in more limited circumstances. Specifically the requirement must be enforced in regard to:

- all holders of new surface water rights permits;
- all holders of existing surface water rights permits greater than one cubic foot per second;
- all holders of existing surface water rights permits diverting from sources that support salmonid fish stocks classified as “critical and depressed” by the Washington Department of Fish and Wildlife; and
- all holders of existing groundwater rights withdrawing from sources that support salmonid fish stocks classified as “critical and depressed” by the Washington Department of Fish and Wildlife.

In regard to groundwater, the Department of Ecology may require persons obtaining new water rights permits to meter their withdrawals, or to measure them by other approved means. (Revised Code of Washington, § 90.44.450.) State law exempts certain small groundwater withdrawals from the requirement of obtaining a permit, but allows the Department of Ecology to require that anyone making such exempt withdrawals “furnish information as to the . . . quantity of that withdrawal.” (Revised Code of Washington, § 90.44.050.) Department officials report that they have “no intention” of requiring measurement of exempt wells. The Department is also authorized to investigate the state’s groundwater resources, and, in so doing, may “require reports” from each groundwater appropriator as to the amount of their withdrawals. (Revised Code of Washington, § 99.44.250.)

Metering and measurement of new groundwater permits is not required, except where: (1) such permits are granted in areas where salmon stocks are depressed or critical, as determined by the state Department of Fish and Wildlife, and (2) the Department of Ecology has a basis for believing that the groundwater right may affect surface waters supporting depressed or critical stocks. (*American Rivers, et al. v. Washington State Dept. of Ecology*, Thurston County Superior Court, civil case no. 99-2-00480-6, Order Filed March 22, 2000, para. 3.)

Where and how is water use measured?

Water use is to be measured at the point of diversion by means of “metering or other approved methods.” This measurement requirement is implemented by means of a condition that the Department of Ecology imposes on water rights permits.

In 1993 the state Legislature enacted the legislation requiring measurement by diverters and enforcement by the Department of Ecology. In 1994, the state legislature cut the Department’s budget and the Department lost approximately 70% of its staff. In 2000, a Washington state court held that the Department of Ecology had not been complying with the statute. (*American Rivers, et al. v. Washington State Dept. of Ecology*, Thurston County Superior Court, civil case no. 99-2-00480-6.) To conform with the court’s order, the Department has drafted new regulations. (To be codified at Washington Administrative Code (“WAC”), chapter 173-173.) Those regulations would require measurement and establish “standards of acceptability for measuring devices and methods.” Under the proposed regulations, no withdrawal or diversion of water is allowed to be made unless the required measuring devices and facilities are in proper operating condition, or are being repaired and the diverter provides “a reasonable estimate” of use during that time. (Proposed WAC, § 173-173-090, subds. (1)-(3).)

The proposed regulations include standards for accuracy of measurement devices and methods, but do not require specific technologies or systems. That is, they use a performance standard approach.

For *pressure systems*, meters must be totalizing, and the default required level of accuracy for meters is +/- 5% and for the “measuring system” as a whole +/- 10%, but those levels can be changed by the Department of Ecology on its own or upon request of a water user. (Proposed WAC, § 173-173-100, subds. (1)-(4).) For other conditions needed to ensure accurate and precise measurement, the regulations also point to “generally accepted industry standards,” including those of the American Water Works Association and information provided by measuring device manufacturers. (Proposed WAC, § 173-173-090, subd. (6).)

For measurement on *open channels*, the default required level of accuracy for the “measuring system” as a whole is +/- 10%. (Proposed WAC, § 173-173-130, subd. (1).) For other conditions needed to ensure accurate and precise measurement, the regulations also point to “generally accepted industry standards,” including those of the U.S. Bureau of Reclamation’s *Water Measurement Manual, 3rd edition*, and information from the manufacturer or designer.

Indirect and alternative methods are also contemplated. In specified circumstances, power consumption data may be substituted for more direct flow measurement methods. (Proposed WAC, § 173-173-160.) Alternative measurement devices and methods are allowed if approved

by the Department of Ecology in writing and a registered professional engineer certifies that the approach will achieve the required accuracy. (Proposed WAC, § 173-173-170.)

Who reports, compiles, stores, distributes, and uses measurement information and how?

Persons required to measure and report water use will be required to report the “maximum instantaneous discharge (flow rate) of water diverted or withdrawn over the reporting period.” (Proposed WAC, § 173-173-060, subd. (1).) Average diversions of greater than 200 gallons per minute will be recorded daily; average diversions of 10-200 gallons must be recorded weekly; and average diversions of less than 10 gallons per minute must be recorded monthly. (Proposed WAC, § 173-173-060, subd. (2).) Regardless of the size of the average diversion or length of the recording period, all reporters must include annual total volume and file the reports annually in January and February. (Proposed WAC, § 173-173-060, subd. (2).)

The Department of Ecology anticipates a “flood” of data from implementation of the statute and new regulation. No system is in place yet for management of the data. The Department has hired a programmer who is looking at this issue. By the end of 2002, the Department hopes to have a data management system in place, including an internet-based capability for completing and submitting required forms.

Statewide, the Department presently has approximately 6 Full Time Equivalent (“FTE”) staff assigned to measurement work and another 4 FTE assigned to compliance work generally, some of which includes compliance with measurement requirements.

What are the purpose(s), benefits, and problems of this approach?

As indicated by the emphasis on “critical and depressed” salmonid streams, one prominent purpose of the measurement regime is:

- maintenance of adequate instream flows for protection of salmonid habitat.

Other purposes referenced in the regulations and supporting documents include:

- verifying water rights compliance;
- providing a basis for curtailing diversions in excess of authorized water rights in order to make more water available for aquatic habitat;
- determining the availability of water for further appropriation;
- identifying opportunities for more efficient water use;
- conducting any needed hydrologic studies; and
- maintaining flexibility in the approach in order to implement any recommendations of watershed planning groups.

One potential unintended consequence identified as a concern by the Department of Ecology “is that water users may feel compelled to maximize their water use such that the quantity equals the amount originally specified by a water right permit, certificate or claim. This is because a user may fear that he or she will relinquish the right to divert water that is not actually put to beneficial use. The measurement of water use and the reporting of water use data to the state may heighten this concern. However, an important element of beneficial use is that the water use must be reasonable and not wasteful. Diverting or withdrawing a certain quantity of water does not give the appropriator a legal right to that quantity if it exceeds what is reasonable for a specified use.” (Environmental Checklist for proposed WAC, § 173-173-060.)

Does actual practice live up to intended policy incentives or legal requirements?

No. The Department of Ecology recently lost a lawsuit in which environmental advocacy groups argued that the Department had failed to properly implement and enforce the law.

What documents already exist on this issue (e.g., cost/benefit analyses)?

The Department of Ecology has prepared a form of cost-benefit analysis in connection with its current proposed regulation. This analysis is contained in a so-called “Small Business Economic Impact Statement.” (Washington State Register, 01-16-131, filed July 11, 2001.) As required under Washington state law, the analysis only focuses on private sector entities. The analysis found that the economic impacts of the regulation fell disproportionately on smaller businesses, but that the impacts were not large relative to revenues for small or large businesses (i.e., ranging from \$0.0001 per \$100 of revenue to \$0.11 per \$100 of revenue. The analysis points to the following features of the proposal as tending to mitigate impacts on smaller enterprises: (1) use of performance standards; (2) reduced frequency of required recording and delayed reporting for smaller diverters; (3) provision for measurement by indirect and alternative means; (4) provision for alternative reporting formats; (5) the state legislature appropriated \$3.4 million in 2002-2003 for measuring devices and stream gauges (although it is not clear whether these monies can be used for measurement of diversions).

Under the state Administrative Procedures Act, the Department must also determine before adoption that the benefits of adopting the rule will exceed the costs of the rule, considering both quantitative and qualitative factors. This analysis has not yet been completed, but will probably be due no later than mid-2002.